THE DEPOSITIONAL ENVIRONMENT OF THE ORGANIC DEPOSITS ON THE FORESHORE AT NORTH DEEWHY, NEW SOUTH WALES

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Synopsis

Pollen analysis of the coastal site at North Deewhy necessitates qualification of a previously published statement that could be taken to imply that the peat at this site is of brackish or marine origin, and that it is *ipso facto* evidence of a higher-than-present sea level stand less than 4,000 years ago.

The so-called " peat ", exposed on the foreshore at North Deewhy (southern side of Long Reef, lat. 33° 44′ S., long. 151° 19·7′ E.), has attracted attention for many years and was the subject of a radiocarbon dating (Hubbs, Bien and Suess, 1963).

I was asked in 1962 to pollen-analyse a sample from this deposit to find whether marine influence was indicated. The position of this sample in the sequence was apparently at the same level as the C_{14}-dated sample, i.e. the base of the organic deposits, just above heavy blue clay. The analysis showed high *Casuarina* values (*Casuarina* is only dominant at the base of the sequence), rather high Chenopodiaceae values and the presence of Hystrichosphaeridae, which were then generally regarded as brackish and marine indicator organisms. On this basis, it was concluded that the sample did show some evidence of proximity to the sea.

The C_{14} sample was subsequently published (*loc. cit.*, p. 259, sample LJ451), the date being 3980 ± 150 yrs. (2030 B.C.), and bore the comment " The peat is possibly indicative of a higher-than-present sea-stand ; pollen analysis indicates that it is probably of brackish or saltwater origin ". This comment goes further than the data available warranted at the time, since peat of saltwater origin in this latitude would almost necessarily be a mangrove peat, and none of the palynological evidence indicated mangrove presence. Except for the Hystrichosphaeridae, the aquatic plants and algae identified were freshwater forms, though some were euryhaline. The determination of the depositional environment of this peat is crucial to its use as evidence of sea-level change, since, if the peat is of salt or brackish water origin, its position must indicate a sea-level higher than to-day's, whereas if it is essentially a freshwater environment (even if influenced by proximity to the sea) it can offer evidence only of a negative kind.

A pollen analysis of the entire short vertical sequence is now available. Fig. 1 (*a*) represents the pollen of woody plants and herbaceous plants of apparently non-local origin. Fig. 1 (*b*) represents aquatic and swamp plants and other locally produced herbs. By " local " is meant those plants most likely to have been floristic components of the actual area of deposition at the time. These latter are expressed as a percentage of the pollen sum formed by the elements of Fig. 1 (*a*). The stratigraphic sequence at the point of sampling is depicted on the right-hand side of Fig. 1 (*a*) and is as follows :

0 cm. upwards (arbitrary datum)	..	Dune sand with plant roots
17 cm.– 0 cm.	.. ..	Sandy limnic humus, more peaty at base
43 cm.–17 cm.	.. ..	Humified and compressed coarse detritus mud
63 cm.–43 cm.	.. ..	Compressed grey-brown fine detritus mud
Below 63 cm.	.. ..	Stiff blue-grey clay.

At an undetermined depth the blue clay appears to be resting on eroded brick earth (laterite), which outcrops seawards and can also be seen dipping under the deposits farther east along the shore.

The pollen diagrams, from bottom to top, show :

(i) Shallow lacustrine conditions with *Chara* and *Pediastrum*, *Triglochin* (or *Potamogeton*), Cyperaceae and probably *Casuarina* fringing woodland.

(ii) *Casuarina* being replaced by Eucalyptoideae : declining *Chara*, but desmids (*Pleurotaenium* and *Cosmarium*) abundant ; Dinoflagellates and Hystrichosphaeres becoming commoner.

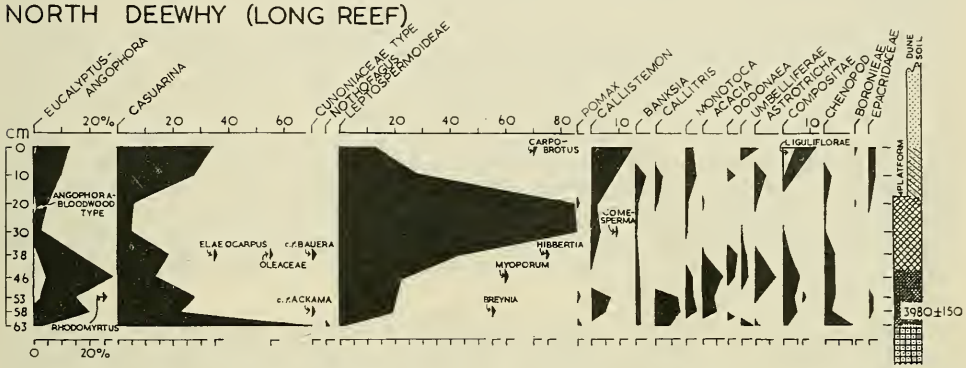

Fig. 1*a*. Pollen diagram of deposits at North Deewhy : Arboreal and herbaceous pollen other than local and swamp plants.

The *Angophora* — bloodwood eucalypt type is shown (white) as a component of the total *Eucalyptus-Angophora* pollen percentage.

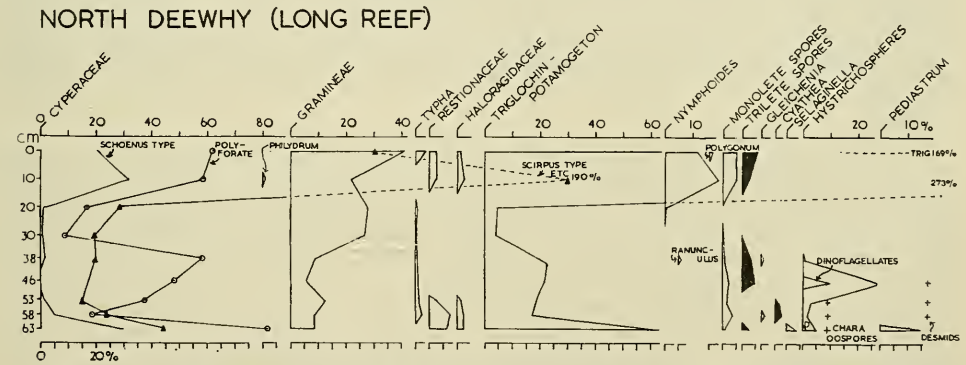

Fig. 1*b*. Pollen diagram of deposits at North Deewhy : Local (i.e. presumed components of the peat) flora, expressed as a percentage of pollen sum of Fig. 1*a*. *Cyathea* and trilete spores other than *Gleichenia* are percentaged with the non-local flora, but are included with other Pteridophytes for convenience.

(iii) The fine detritus mud changing quite sharply to a coarse detritus mud ; much higher values for Leptospermoideae (*Leptospermum*, *Melaleuca* and *Kunzea* not being easily separable) probably indicating nearby ti-tree swamp, but wood fragments occurring neither at the point of sampling or elsewhere along the exposure. The influx of Leptospermoideae is probably responsible for an artificial lowering of the background pollen of *Eucalyptus*, etc.

(iv) Peat development, with occasional very compressed Cyperaceae rhizomes, at about the point at which Cyperaceae pollen becomes abundant in the profile. This level also corresponds to a step cut in the deposit which is apparently due to a difference in erodability of the two sediment types.

(v) The peat grading into the more limnic sandy-humic layer upwards, itself not sharply demarcated from the overlying sand, but apparently waterlogged conditions prevailed to the time of obliteration of the swamp, as indicated by the vast quantities of *Triglochin* and Cyperaceae pollen and the entry of *Philydrum* and *Nymphoides* into the profile. Leptospermoideae, apart from *Callistemon*, which actually increases slightly, decline towards the top of the profile, resulting in a recovery of the non-local *Casuarina*, Eucalyptoideae and *Callitris*.

It is now clear that the lower third of the sequence represents a lake or freshwater lagoon with a desmid and *Pediastrum* phytoplankton. There is no warrant for the belief that the deposit was in a marine or brackish (as that word is usually understood) environment, and the presence of ferrous sulphide (FeS_2) crystals, which occur in the basal lake mud, is quite compatible with formation in a freshwater lagoon under slight marine influence (e.g. Degens, 1965). The freshwater tolerance of hystrichosphaeres (in this context, microplanktonic fossils with spherical bodies and radiating processes that are not obvious Dinoflagellates) appears to be higher than formerly supposed (Churchill and Sarjeant, 1962), and in the general context of this deposit they can hardly be said to provide clear evidence of high salinity.

The central part of the sequence, which lacks even equivocal indicators of salinity, must have been produced under waterlogged or near-waterlogged conditions if not open water, because of the dominance of swamp-living angiosperms. A slight rise in water level may be implied by the replacement of a Leptospermoideae swamp by a Cyperaceae-*Nymphoides-Triglochin* swamp in the upper part of the sequence, but the absence of any wood fragments makes the precise meaning of the high Leptospermoideae values uncertain. The changes in flora indicated by the pollen analysis do not reflect a straightforward plant succession and could have been brought about by minor changes in water level, which itself would be influenced by factors such as the movements of nearby dunes, shoreline recession and migration of the mouth of the nearby Deewhy Lagoon.

An opportunity to obtain the true level of the deposit did not occur until this year. Consequently, the precise position from which the samples were taken could no longer be located, though the general position was located within a few metres. The outcrop along the beach is stratigraphically uniform and fairly flat except for a slight rise at the eastern edge. Thus, the level obtained is believed to be representative of the outcrop as a whole. At the new point of measurement the surface of the deposit is 3·0 m. above standard datum (N.S.W. standard datum is 2·93 ft. or 0·89 m. above Indian Springs Low Water at Fort Denison, Sydney). The tidal range at Narrabeen is approximately the same as at Fort Denison, i.e. 0 to +2·0 m., and the clay/mud transition is 2·2 m. above standard datum, the deposit being 80 cm. thick. A second measurement a few metres from the first gave a thickness of 75 cm., compared with 64 cm. at the point of sampling in 1965 when the pollen samples were collected.

Allowing for the compression which has taken place during the burial of the sediments under dune sand, the deposit appears to have formed within about 2·3 m. of local HHWS. The water level in the existing nearby Deewhy Lagoon was 0·9 m. below the peat base at the time of survey and peat forming at the present day round the margin of the lagoon is approximately 0·6 m. below the base of the peat on the foreshore. One can point to a number of still existing freshwater peat swamps, at levels ranging from several metres higher

to about 0·5 m. lower than the North Deewhy deposits, in similar areas along the central coast of New South Wales (e.g. Kurnell Peninsula). In each case local water-table conditions determine the level at which peat formation occurs. Needless to say, such deposits cast very limited light on existing sea level.

An interesting sidelight of the work is the finding of a few pollen grains of several unexpected plants, e.g. *Nothofagus*, *Rhodomyrtus* and cf. *Ackama*. The two latter seem to represent a coastal rainforest or wet sclerophyll element in the flora. Rainforest remnants still grow on the Narrabeen shales of the Palm Beach Peninsula, e.g. at Bilgola, a few miles to the north of Deewhy, though neither of these genera are now present locally. *Nothofagus*, on the other hand, appears to represent a long-range component. The grain is of the *N. moorei* type, the nearest source of which, today, would be the Barrington Tops forests, *ca.* 200 km. distant. The single grain is unlikely to be a contaminant, as it contains small ferrous sulphide crystals, as do other pollen grains at this level.

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